

**CIBO Estimated Capital Costs For Air Pollution Control Equipment For Gas 2-Fired Industrial Boilers and Process Heaters<sup>i</sup>**

<b>Pollutant</b>	<b>Particulate Matter (PM)</b>	<b>Hydrogen Chloride (HCl)</b>	<b>Carbon Monoxide (CO)</b>	<b>Dioxin/Mercury (Hg)</b>
<b>Likely Additional Control Required</b>	Fabric Filter (FF)	Scrubber (e.g., spray dryer or wet scrubber)	Catalytic Oxidation (CATOX)	Carbon Injection (CI)
<b># of Gas 2-Fired Boilers and Process Heaters</b>	64 of the 71 gas 2-fired units will need a new FF (none of these boilers have any HAP APCD controls installed)	0 of the 71 gas 2-fired units will need scrubbers	68 of the 71 gas 2-fired units need CATOX	0 of the 71 gas 2-fired units need CI
<b>Comments/ Assumptions</b>	<ul style="list-style-type: none"> <li>• If a unit did not already have a FF or ESP and there was information in the EPA database that indicated the unit cannot meet the limit or there was no emissions information, we assumed a new FF.</li> <li>• If the unit already had a FF or ESP and there was information in the EPA database that indicated the unit cannot meet the limit we assumed an upgrade to the existing FF or ESP.</li> <li>• FF base capital cost \$7 MM<sup>ii</sup>; FF/ESP base upgrade capital cost \$4 MM. <sup>iii</sup></li> </ul>	<ul style="list-style-type: none"> <li>• If there was information that indicated the unit cannot meet the limit, we assumed either a scrubber upgrade or new scrubber depending on whether the unit currently had a scrubber. <sup>ii</sup></li> <li>• If there was no emissions information we assumed the unit would meet the limit with no control, based on EPA emission factor memorandum.</li> <li>• Scrubber base capital cost \$8 million; scrubber base upgrade capital cost \$4 million. <sup>iv</sup></li> </ul>	<ul style="list-style-type: none"> <li>• If there was information that indicated the unit cannot meet the limit, then we assumed that capital would be necessary to install a CO catalyst. <sup>ii</sup></li> <li>• Base capital cost of \$3 million was assumed for CO controls (either projects to improve combustion or fuel feed or installation of a CO catalyst). <sup>iv</sup></li> </ul>	<ul style="list-style-type: none"> <li>• If there was information in the EPA database that indicated the unit cannot meet the limits, we added carbon injection.</li> <li>• If there was no emissions information we assumed the unit would meet the limits with no control, based on EPA emission factor memorandum. <sup>ii</sup></li> <li>• A fixed cost of \$1 million was assumed for installation of a Carbon Injection system for Hg and/or dioxin control, as these systems do not vary much in cost by boiler size.</li> </ul>
<b>Total Capital Cost to Gas 2-Fired Units: \$577 million</b>	\$393 million	\$0	\$183 million	\$0
<b>Capital Cost Per Unit</b>	<ul style="list-style-type: none"> <li>• Range of Costs Per Unit: \$1 to 13.7MM</li> <li>• Average Per Unit Cost: \$6.1MM<sup>iv</sup></li> </ul>	<ul style="list-style-type: none"> <li>• Range of Costs Per Unit: \$0 to 0MM</li> <li>• Average Per Unit Cost: \$0MM</li> </ul>	<ul style="list-style-type: none"> <li>• Range of Costs Per Unit: \$435k to 5.9MM</li> <li>• Average Per Unit Cost: \$2.6MM</li> </ul>	<ul style="list-style-type: none"> <li>• \$0 million per unit</li> </ul>

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<sup>i</sup> The chart includes data for 71 gas 2-fired units >10 MMBtu/hr (gas 2 category is gas-fired boilers that burn gases other than natural gas/refinery gas that do not meet the H<sub>2</sub>S and Hg Gas 1 criteria). The units are derived from 71 units in the gas 2 MACT subcategory in EPA's Boiler MACT survey database (**note that the only units EPA left in its database as Gas 2 units burn coke oven gas and blast furnace gas – they assumed that all other units will be able to opt into Gas 1 and qualify for work practice standards instead of numerical emission limits**) available here: <http://www.epa.gov/ttn/atw/boiler/boilerpg.html#TECH>. Capital cost estimates are not intended to represent a worst case analysis. Rather, they represent typical retrofit costs for the various scenarios based on published reports, industry information on specific project costs, EPA reports or control device fact sheets, or actual BACT or BART analyses submitted to permitting agencies. A primary resource was the document “Evaluation of Air Pollution Control Costs for the Pulp and Paper Industry,” prepared by National Economic Research Associates (NERA) in May 2003. Note that costs were not scaled from the date of the reference used to 2011 dollars as the intent was to develop an order of magnitude estimate for each control scenario.

<sup>ii</sup> MM stands for million

<sup>iii</sup> The base cost assumes a size of 250 MMBtu/hr, the boiler specific cost was calculated using a 0.6 power function and the actual boiler size in MMBtu (e.g., for a 100 MMBtu/hr boiler or process heater, the cost is the base cost times  $(100/250)^{0.6}$ ).

<sup>iv</sup> Average cost was calculated by adding up the per unit cost for every unit requiring controls to get the total cost for all units and then dividing the total cost by the number of units requiring controls.